POLITECNICO DI MILANO

PhD in MODELLI E METODI MATEMATICI PER L'INGEGNERIA / MATHEMATICAL MODELS AND METHODS IN ENGINEERING - 39th cycle

PNRR 118 PA Research Field: APPLICATION OF MACHINE LEARNING AND NATURAL LANGUAGE PROCESSING TECHNIQUES TO FORECAST MACROECONOMIC AND FINANCIAL TIME SERIES

Monthly net income of PhDscholarship (max 36 months)
€ 1325.0
In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	Digital technologies have induced two significant novelties in the academic and financial community: a huge increase in the amount of information available to forecast financial and macroeconomic time series (big data); and new forecasting techniques based on artificial intelligence (black box models). In particular, information gathered from news and heterogenous sources (e.g. social networks, mobility) turn out be relevant indicators to predict financial and macroeconomic variables (unemployment, GDP growth, inflation). These variables are released with a significant delay and the possibility to forecast them accurately with real time data represents an important advancement. Also the possibility to detect systemic risk events (e.g. bank runs) in due time through real time data available through social networks and payment system represents an interesting opportunity.
Methods and techniques that will be developed and used to carry out the research	The research will aim to exploit advances in the techniques of machine learning (e.g. deep learning) and natural language processing to provide powerful forecasting/detection tools. In particular, following [1], [4], [5], the goal is to use natural language processing techniques to forecast in real time macroeconomic variables.

	Machine learning techniques will be employed to detect systemic risk events building on real time information coming from financial intermediaries, see [2], [3]. These models are in most of the cases black boxes. The development of interpretability tools of the models/results is a key goal of the project. Bibliography: [1] V. Aprigliano, S. Emiliozzi, G. Guaitoli, A. Luciani, J. Marcucci, L. Monteforte, The power of text-based indicators in forecasting Italian economic activity, International Journal of Forecasting, Volume 39, Issue 2,2023: 791-808. [2] M. Azzone, E. Barucci, G. Giuffra, D. Marazzina, A machine learning model for lapse prediction in life insurance contracts, Expert Systems with Applications, 199, 2022. [3] E. Barucci, M. Bonollo, E. Rroji, F. Poli, A machine learning algorithm for stock picking based on information outliers, Expert Systems with Applications, 184, 2021. [4] G. Bruno, J. Marcucci, A. Amttiocco, M. Scarnò, D. Sforzini (2018) The sentiment hidden in Italian texts thorugh the lens of a new dictionary. [5] F. D'Amuri, J. Marcucci, The predictive power of Google searches in forecasting US unemployment, International Journal of Forecasting, 33, 4, 2017: 801-816.
Educational objectives	The PhD student will have the opportunities to increase his/her abilities in the application of machine learning and natural language processing to forecast financial and macroeconomic time series. In particular, the student will develop new methodological tools for sentiment analysis testing their capabilities to provide good forecasts of macroeconomic time series and to detect systemic risk events.
Job opportunities	The program will allow the student to find a job in three main areas: academia, financial industry, regulatory/supervisory authorities. In these areas there is a strong request of competent and skilled workers.
Composition of the research group	2 Full Professors 1 Associated Professors 2 Assistant Professors

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	2 PhD Students
Name of the research directors	Prof. Emilio Barucci

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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	662.5 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	Research Department of Bank of Italy
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	to be defined
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Educational activities (purchase of study books and material, funding for participation to courses, summer schools, workshops and conferences): financial aid per PhD student per year 1st year: max 1.800,47 euros 2nd year: max 1.800,47 euros 3rd year: max 1.800,47 euros The PhD students are encouraged to take part in activities related to teaching, within the limits allowed by the regulations.1 individual PC per student +several shared PC. Access to one cluster with 32 processors and 384 GB RAM, and to several multi-processor servers. Study and research period visiting the Research Department of Bank of Italy, Rome. The Research Department of Bank of Italy represents a research center with a strong reputation on forecasting financial time series at the international level.